XMM-NEWTON OBSERVATIONS OF THE SOFT INTERMEDIATE POLAR RXJ062518.2+733433

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ABSTRACT

We report on observations of the soft intermediate polar 1RXSJ062518.2+733433 in the X-rays, UV, and the optical. Synchronously to a 30 ksec exposure with XMM-Newton's EPIC, the OM observed in filter UVM2, and ground-based observations were performed in the R-band. The X-ray observation covers 1.75 binary orbits and 25 white dwarf spin cycles, in which the EPIC-PN collected ~37000 source counts. A timing-analysis was performed on the data of various energy bands to determine the origin of the variability. The hard X-rays are varying mainly on the white dwarf's spin period, whereas the soft X-rays and the UV/optical data show strong variability on side-band periods. The average X-ray spectrum can be fitted by a black-body with kT=60 eV and two MEKALs with different amounts of absorption.

1. RESULTS

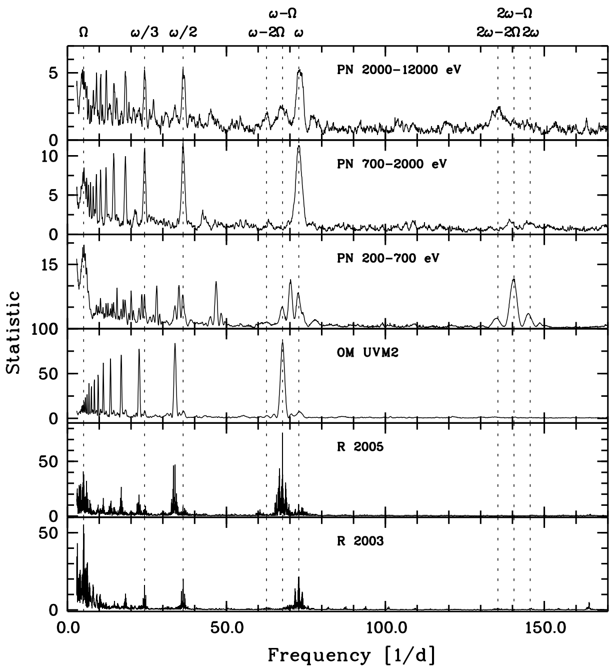

Figure 1. Periodograms of the light-curves from Fig.3, and, for comparison, of the R-band data from 2003.

Fig. 3 shows the light curves obtained simultaneously on March 31, 2005. In all wavelength ranges a variability near 20 min is seen. In the soft X-rays (200-700 eV) and in the R-band data there is a strong dependence of the amplitude of variability on the orbital phase. The analysis is supported by additional optical photometry obtained in three nights in March and April 2005.

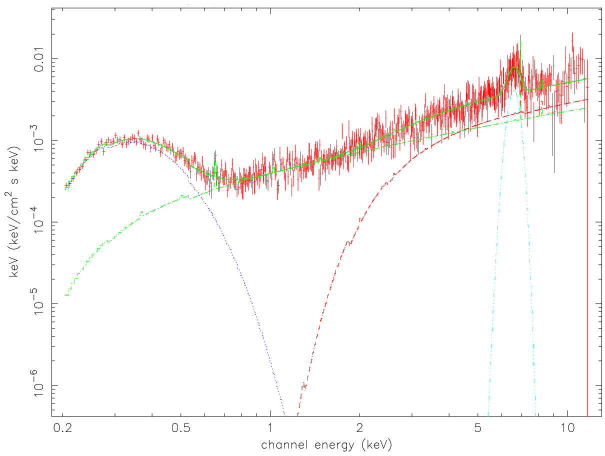

Figure 2. The EPIC-PN spectrum with overplotted fit and its components. (Parameters in Tab. 1)

In Fig. 1 the results of a period analysis with AOV in the different energy bands are shown. The dominating period in the harder X-ray bands is identical to the value for the spin period tentatively derived by Staude et al. (2003), $P_{spin} = 1187.246(4)$ s ($P_{orb} = 16987(23)$ s). At longer wavelengths, the variability on this period becomes weaker. In the soft X-rays, $2\omega - \Omega$ and $\omega - \Omega$ are also significant, while the latter is the dominant signal in the UV and the optical. The basic frequencies ω and Ω are marked in the figure, as well as (sub)harmonics of the spin frequency and side-band frequencies. AOV (Schwarzenberg-Czerny, 1989) tends to create sub-harmonics (contrary to the Fourier-transform, which creates harmonics).

The EPIC-PN spectrum is shown in Fig. 2. The data were fitted with Xspec using a multi-component model, *wabs*$_1$*(mekal*$_1$*) + wabs*$_2$*(mekal*$_2$ *+ bbody + gaussian).*

2. DISCUSSION

Compared to the R-band data from Staude et al. (2003), the object was nearly one magnitude fainter in 2005. In

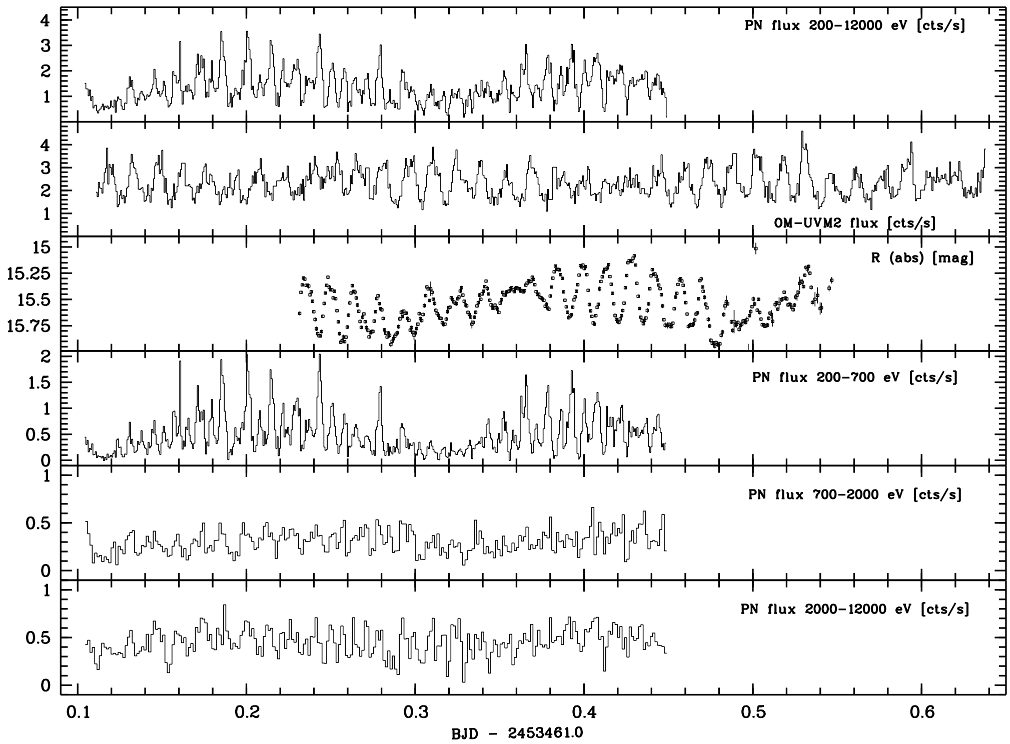

Figure 3. The light-curves of RXJ0625, simultaneously obtained on March 31, 2005, by XMM (PN and OM) and with the AIP 70cm-telescope (R). The data shown here are binned in time, 60s for the top four panels, 120s for the lower two.

Table 1. The main parameters of the spectral model.

wabs_1	nH	5.4 (1.3) 10^{22} cm^{-2}
mekal_1	kT	not restricted
wabs_2	nH	2.7 (0.5) 10^{20} cm^{-2}
mekal_2	kT	not restricted
bbody	kT	60 (1) eV
gaussian	LineE	6.6 (0.04) keV
	Sigma	0.28 (0.04)keV

2003, the optical short-term variability occurred on the period which we could now identify with the true white dwarf spin (Fig. 1, lowest panel), whereas in 2005 it occurred on $\omega - \Omega$.

The optical data from 2003 can be interpreted such, that a higher mass-loss rate of the secondary star led to the formation of an accretion disk, so that the short-term variation in the optical data is tracing the reprocessing sites of the radiation from the accreting pole on its radially symmetric inner rim.

The beat-period ($\omega - \Omega$), as the dominant period in the optical and UV light from 2005, shows that their emission or the visibility of their origin was strongly dependent on the orientation of the white dwarf's magnetic field with respect to the secondary star. As indicated by the lower brightness of the system, the mass-loss rate was lower, and it is likely that the matter was captured earlier by the magnetic field, preventing the formation of a highly symmetric accretion disk.

In the fit to the PN spectrum, the plasma temperature for the MEKAL components was not restricted. A successful fit was achieved only after inclusion of a second highly absorbed MEKAL component. In a phase-averaged spectrum this can be understood as being the result of either two accreting poles with different accretion conditions, or as one (visible) accreting pole with a changing amount of absorption due to occultation by an accretion curtain.

The hard X-ray component is thought to be originating in a shock in the accretion column above the magnetic pole. Since there is nearly no variability of the count-rate of the hard photons on the beat frequency, the accretion rate does not seem to be dependent on the stars' orientation. Thus the accretion leading to the emission of hard photons is likely to happen via an accretion disk, although this statement seems to contradict the conclusions drawn from the other energy bands.

The soft X-ray photons (200 - 700 eV) are fitted well by a black-body, and seem to be arising on the white dwarf (because of the strong signal at ω). The strength of $\omega - \Omega$ shows that the orientation of the stars has influence on the emission. Stream-fed accretion, penetrating the white dwarf's surface and heating it, is thus likely to be the origin of the soft X-ray component. The frequency $2\omega - \Omega$ is a hint to a second accreting pole, opposite to the main one, since it denotes the existence of a similar accretion geometry after just half a spin-cycle (Wynn & King, 1992).

We could not yet identify the peak at $\sim 47\,\mathrm{d}^{-1}$ and its sub-harmonics with any side-band frequency of the main periodicities.

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